

# TRAVEL TIME AND SURVIVAL SMOLT PHYSIOLOGY

8740100

## SHORT DESCRIPTION:

Provide information on smoltification and disease in juvenile salmonids for Smolt Monitoring Program and other mainstem passage monitoring and smolt research projects. Develop ways to minimize residualism and precocity of hatchery steelhead.

## SPONSOR/CONTRACTOR: USGS-BRD, CRRL

USGS, Biological Resources Division, Columbia River  
Research Laboratory

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## SUB-CONTRACTORS:

N/A

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## GOALS

### GENERAL:

Supports a healthy Columbia basin, Maintains biological diversity, Adaptive management (research or M&E)

### ANADROMOUS FISH:

Research, M&E

### NPPC PROGRAM MEASURE:

4.2A; 5.0A; 5.7A.4; 5.8A.8; 5.9A.1

### BIOLOGICAL OPINION ID:

NMFS BO RPA 13a and 16

### OTHER PLANNING DOCUMENTS:

NMFS Snake River Recovery Plan (March 1995) 2.1.d.5.

### TARGET STOCK

Snake & Columbia River Steelhead

Snake & Columbia River Fall Chinook

Snake & Columbia River Summer Chinook

Snake & Columbia River Spring Chinook

### LIFE STAGE

Smolt

Smolt

Smolt

Smolt

### MGMT CODE (see below)

S, A

S, A

S, A

S, A

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## BACKGROUND

### Subbasin:

Columbia River Basin

### Project is an office site only

### Habitat types:

Hatcheries, Tributaries, Mainstem

## HISTORY:

This project was initiated in 1987 to provide a reliable time series of information on smolt condition to assist the in-season management of the Water Budget and other flow augmentation to the best advantage of emigrating juvenile salmon and steelhead in the Columbia and Snake rivers. Specific objectives of the project are listed below. Based on the needs of fish managers, objectives 1, 2, & 3 are no longer needed; objectives 4 & 5 continue and objective 6 has become a separate project.

1. (Completed) Develop and use non-lethal techniques to monitor smolt condition. We have developed several non-lethal methods including a non-lethal (micro-gill clip) method to determine gill ATPase activity. Additional non-lethal methods include measurements of changes in skin reflectance and body morphology during smolt development and activity of skin lysozyme as a measure of fish health.

2. (Completed) Collect, analyze, and report biological information on the condition and smoltification of wild- and hatchery-

reared juvenile salmon and steelhead migrants in the Columbia and Snake rivers. This activity was conducted annually from 1987 to 1996.

3) (Completed) Report real-time data on smolt condition and health to the Fish Passage Center (FPC) to improve the scientific information on which to base in-season flow and spill management decisions directed toward improving passage conditions for juvenile salmon and steelhead in the lower Columbia River. Reports were made to FPC during the smolt migrations from 1987 to 1996. This objective was conducted with branded hatchery release groups from 1987 to 1992 and with in-river PIT-tagged fish from 1993 to 1996

(4) Analyze data collected from 1987 through 1996 with the goal of improving the effectiveness of the hydropower and hatchery systems to protect juvenile salmonids and improve their survival. We have supplied data and our analyses to managers annually. In 1997 we will begin in-depth analyses of our multi-year, multi-variable data sets to describe relations between physiological variables, environmental factors and survival and to determine which combination of variables are the best predictors of adult survival.

5) Monitor condition and health of fish used for the Lower Granite Reservoir survival study (NMFS) and other projects in the Columbia Basin. We also collaborate with numerous other projects dealing with Columbia River salmonids (see lists in Section 60 & 70). (A) We anticipate working with the NMFS survival study again in 1998 and with other large scale PIT tag studies in the Snake River. (B) In 1997 we will begin a collaborative study to limit the in-river impacts of hatchery steelhead on other salmonids.

6) In fall 1994, tasks were added to develop a monitoring and research program on the effects of gas bubble trauma (GBT) on migrating juvenile salmonids. Non-lethal ways for assessing GBT were developed. Tasks associated with GBT are now in a separate project entitled: Gas Bubble Trauma Monitoring and Research of Juvenile Salmonids.

#### **BIOLOGICAL RESULTS ACHIEVED:**

From 1988 through 1996, this project provided an annual assessment of smolt condition to assist the management of the Water Budget and other flow augmentation to the best advantage of emigrating juvenile salmon and steelhead. The information this project provided will be tracked from its use in decision-making for mainstem flow, spill management and hatchery practices to effects of these actions on smolt survival and subsequent adult returns. The time series information this project provides will contribute to the evaluation of the relationship between the environmental conditions, smolt condition, smolt survival and adult production once we have adequate evaluation tools to measure survival through the different life stages. Evaluation of the effectiveness of yearly downstream migration protection actions are contained in the annual project reports and reports of the FPC. Analyses of adult return data for branded hatchery release groups will be used to determine if smolt and fish health data collected from migrants is predictive of long term survival. This project has also supplied information on the condition and health of fish used in a large number of other projects (see Sections 60 & 70).

#### **PROJECT REPORTS AND PAPERS:**

Smolt condition data is provided to the Fish Passage Center for input into real-time in-season water management decisions. A series of quarterly and annual reports under the titles "Correlation of biological characteristics of smolts with survival and travel time" and "Assessment of smolt condition for travel time analysis" have and continue to be produced by this project. The BPA publication numbers for the Annual Report series follow: Annual Report 1987 DOE/BP-35245-1 June 1988; Annual Report 1988 DOE/BP-35245-2 December 1989; Annual Report 1989 DOE/BP-35245-3 November 1990; Annual Report 1990 DOE/BP-35245-4 December 1991; Annual Report 1991-1992 DOE/BP-35245-5 May 1994; 1993-1994 and 1995 draft reports.

Other Scientific Reports and Publications:

Beeman, J. W., D. W. Rondorf, and M. E. Tilson. 1994. Assessing smoltification of juvenile spring chinook salmon (*Oncorhynchus tshawytscha*) using changes in body morphology. *Canadian Journal of Fisheries and Aquatic Science* 51:836-844.

Beeman, J. W., D. W. Rondorf, M. E. Tilson, and D. A. Venditti. 1995. A non-lethal measure of smolt status of juvenile steelhead based on body morphology. *Transactions of the American Fisheries Society* 124:764-769.

Beeman, J. W. and D. W. Rondorf. In review. Estimating the effects of river flow and smoltification on the travel time of juvenile salmonids in the Columbia and Snake rivers. *Transactions of the American Fisheries Society*.

Haner, P. V., J. C. Faler, R. M. Schrock, D. W. Rondorf, and A. G. Maule. 1995. Skin reflectance as a non-lethal measure of smoltification for juvenile salmonids. *North American Journal of Fish Management* 15:814-822.

Hans, K., A. G. Maule, P. Haner, J. Beeman, R. Schrock, J. Hotchkiss, and S. Sauter. In preparation. Wild and hatchery salmonids differ in smolt indices during migration in the Snake and Columbia rivers.

Jeney, Z., G. Jeney, and A.G. Maule. 1992. Cortisol measurements in fish. pages 157-166. in J. S. Stolen, T. C. Fletcher, S. L. Kaattari, and A. F. Rowley (eds.) Techniques in Fish Immunology, 2. SOS Publications, Fair Haven, NJ.

Maule, A. G. P. Haner, J. Beeman, R. Schrock, and D. Rondorf. In preparation. Changes in smolt indices during migration as predictors of adult returns.

Maule, A.G., and M.G. Mesa. 1994. Efficacy of electrofishing to assess plasma cortisol concentration in juvenile chinook salmon passing hydroelectric dams on the Columbia River. North American Journal of Fisheries Management 14:334-339.

Maule, A.G., D. Rondorf, J. Beeman, and P. Haner. 1996. Incidence and severity of Renibacterium salmoninarum in spring chinook salmon in the Snake and Columbia rivers. Journal of Aquatic Animal Health 8:37-46.

Maule, A.G., R. M. Schrock, C. Slater, M. S. Fitzpatrick, and C. B. Schreck. 1996. Immune and endocrine responses of adult spring chinook salmon during freshwater migration and sexual maturation. Fish and Shellfish Immunology 6:221-233.

Schrock, R. In preparation. Changes in mucus lysozyme from juvenile Pacific salmon during smoltification and disease.

Schrock, R. M., J. W. Beeman, D. W. Rondorf, and P. V. Haner. 1994. A microassay for gill sodium, potassium-activated ATPase in juvenile pacific salmonids. Transactions of the American Fisheries Society 123:223-229.

#### **ADAPTIVE MANAGEMENT IMPLICATIONS:**

Measurements of physiological variables can provide information on the short term effects of management actions. For example, travel time of juvenile chinook salmon decreases as water flow increases, the positive effects of flow are greatest in fish with the highest level of smoltification. This information allows managers to maximize benefits of water manipulations. We have also begun analyses of adult return data to determine if measures of smoltification in migrating juveniles are predictive of long-term survival. Numerous other projects (see Sections 60 & 70) use data that we supply on smoltification, fish health and performance tests to assess the efficacy of hatchery practices or to determine the condition of fish collected from the river at different times during the migration. This project has responded to changing regional needs by developing non-lethal sampling techniques, adapting sampling protocols to reflect changes in management information needs and providing service for other research and monitoring projects.

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## **PURPOSE AND METHODS**

#### **SPECIFIC MEASUREABLE OBJECTIVES:**

Because of management decisions prior to 1997 our objectives for 1998 have been reduced from those of previous years. These numbers correspond to the original objective numbers for the project and reflect completion or termination of objectives 1, 2, & 3: (4) Analyze data collected from 1987 through 1996 with the goal of improving the effectiveness of the hydropower and hatchery systems to protect juvenile salmonids and improve their survival; (5A) Monitor the condition and health of fish used for the Lower Granite Reservoir survival study (NMFS) and other projects in the Columbia Basin. We will be working with the NMFS survival study again in 1998 and with other large scale PIT tag studies in the Snake River (Idaho F & G; Oregon F & W). (5B) In 1997 we will begin a collaborative study with two groups (Dworshak NFH and Abernathy Salmon Culture Center) in USFWS and several groups with Wash. F & W to limit the in-river impacts of hatchery steelhead on other salmonids. We are in the process of fully developing those proposals. We also collaborate with numerous other projects dealing with Columbia River salmonids (see lists in Section 60 & 70).

#### **CRITICAL UNCERTAINTIES:**

Factors affecting early development and out migration are critical to survival to adult; however, it may be that in the short-term (e.g., the life of this project) factors in the estuary or ocean will override and dampen variability caused during early life stages.

Fish collected at dam bypass systems and at in-river smolt traps are representative of all the fish in the river.

Data collected from branded hatchery releases (1988 through 1992) before release and at downstream dams can be correlated to the return (fishery and hatchery) of adults from those same groups.

Changes in hatchery practices will change the rate of residualism and precocity in steelhead.

## **BIOLOGICAL NEED:**

Objective 4. Research and monitoring programs must consider the biology of the animals with which they are working. This is especially true since the condition and health of smolts changes dramatically during outmigration. For example, data from this project indicated flaws in the design of survival estimates conducted in the late 1980s due to differences in biological measures of control and test fish (see our 1987 Annual Report). Knowledge of the biology of the fish is needed to evaluate the outcome of research studies and management actions. Even though physiological data on smolt quality and fish health may explain a limited amount of the variation in survival (perhaps 5-10%), it is significant given the vast array of variables encountered during salmonid migration that influence salmon survival. Objective 5A. A large number of chinook salmon at Snake River hatcheries will be PIT tagged as part of a survival study. By determining smolt condition and health at the time of release we can determine the physiological conditions optimal for survival and use that information in hatchery operations. By using the "recapture-by-PIT-tag-code" systems at Snake River dams we can determine whether the critical changes in smolt development occur in the hatchery or during migration. Objective 5B. There is concern that some hatchery steelhead trout residualize and become predators of smaller chinook salmon. Several agencies have expressed interest in cooperative research with the objective of determining causes of high percentages of residualization and precocity in Columbia basin steelhead. Because this is a system wide phenomenon, coordination of efforts to design field and laboratory experiments to determine the physiological basis for the problem is desirable. Both the WDFW and USFWS (Dworshak NFH) plan preliminary studies this year, and have requested our assistance. Furthermore, both have expressed interest in our participating by investigating the phenomena observed in the field and hatcheries in carefully designed laboratory experiments. We have previously worked with Mark Schuck (WDFW) on steelhead from the Tucannon River that also experienced high numbers of precocious males that did not out-migrate.

## **HYPOTHESIS TO BE TESTED:**

(1) Smolt condition and health of hatchery spring/summer and fall chinook salmon and steelhead correlate positively with smolt behavior and long term survival. Alternatively, smolt condition and health do not influence behavior or survival and only extrinsic factors control survival. In other words, there is nothing that can be done in the hatcheries to improve survival to adult. (2) Smolt condition of steelhead and/or spring chinook at the time of release from a hatchery influences smolt behavior and long term survival. Alternatively, in-river environmental factors are completely responsible for smolt quality after fish are released and during their emigration. (3) Modification of hatchery practices will alter smolt development and reduce residualization and precocity of steelhead. Alternatively, residualization and precocity of steelhead are determined independent of rearing environment and the only way to insure that steelhead do not impact other salmonids is to not produce them in hatcheries.

## **ALTERNATIVE APPROACHES:**

N/A

## **JUSTIFICATION FOR PLANNING:**

N/A

## **METHODS:**

For Objective 4: Selected physiological measures of fish health, smoltification and stress have been collected from juvenile salmonids of hatchery origin prior to their release, and during their seaward migration. These biological factors and physical factors, including river flow and water temperature, are used in our analyses. All sample collections and analyses are completed using standard methods. Our specific tasks and associated methods are:

- 1) Building a long-term database of biological attributes of juvenile salmonids prior to release from hatcheries in the Columbia basin. We collected tissue samples for determinations of disease state including Bacterial Kidney Disease (BKD) and smoltification via gill Na,K-ATPase activity. We have also collected samples to determine stress level including plasma cortisol, glucose, and osmolality. Tag-return data from the release groups will be completed in the next couple of years. We will analyze these data using multiple regression to determine the value of in-river measures to predict adult survival.
- 2) Estimate the relative effects of smolt condition and river flows on travel time. Multiple regression techniques are used to determine factors influencing migration rates. Fish used under this objective are migrants collected, tagged, and sampled at mainstem dams and floating traps operated by various state and federal agencies.
- 3) Develop indices of smolt condition and health. To date we have: (a) used principal component and discriminant function analyses to develop a successful measure of smoltification based on changes in body shape of juvenile chinook salmon and steelhead; (b) found significant correlations between skin reflectivity measured using a computer-based method and smoltification based on ATPase activity; © used modern laboratory techniques to drastically reduce the amount of tissue needed to determine

ATPase activity; (b) determined that lysozyme in fish mucus, a non-specific immune factor, can be a non-lethal index of fish health.

Objective 5A. Use methods described for Objective 4 to provide physiological data on fish used for estimating survival in the Snake River, recollect PIT-tagged fish at Snake River dams and determine significance of smolt condition at time of release as compared to rate of change during migration. Objective 5B. Collaborate with several groups within USFWS and WDFW to determine protocols for minimizing the impact of hatchery steelhead on other salmonids. This will be accomplished by monitoring smolt development and health of steelhead in various hatchery-treatment groups and recollecting fish in the tributaries and at downstream traps and dams to determine which groups have the least residualism and precocity

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## PLANNED ACTIVITIES

### SCHEDULE:

<u>Planning Phase</u>	<u>Start</u> July, 1996	<u>End</u> March 2001	<u>Subcontractor</u>
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Task Task 4 Objective 4 - Planning is complete.

Objective 5 - Oct. 31, 1997

1997 - Continue analysis of 1988-92 data and adult returns and analyses of total database relative to the value of smolt condition and health data in assessment of survival

1998 - Continue analysis of 1988-92 data and adult returns and analyses of total database relative to the value of smolt condition and health data in assessment of survival

1999 - Continue analysis of 1988-92 data and adult returns

2000 - Continue analysis of 1988-92 data and adult returns

2001 -Complete the analysis of 1988-92 data and adult returns. We anticipate the CWT databases for adult returns to fisheries and hatcheries will be completed by this time.

<u>Implementation Phase</u>	<u>Start</u> Feb. 1998	<u>End</u> March 2001	<u>Subcontractor</u>
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Task 5A Information will be presented to fish managers for implementation Planning will be completed before 1998 funding year.

Feb 1998-Jan 1999 - Collect gill tissue and other smolt and health information on a subsample of chinook salmon PIT tagged at Snake River hatcheries; recollect and sample fish at Snake River Dams; conduct laboratory assays; prepare reports.

Feb 1999.-Jan 2000 - Collect gill tissue and other smolt and health information on a subsample of chinook salmon PIT tagged at Snake River hatcheries; recollect and sample fish at Snake River Dams; conduct laboratory assays; prepare reports.

Feb 2000-Sept 2000 - Collect gill tissue and other smolt and health information on a subsample of chinook salmon PIT tagged at Snake River hatcheries; recollect and sample fish at Snake River Dams; conduct laboratory assays; prepare reports.

Oct 2000 -Mar 2001- Prepare final reports.

<u>O&amp;M Phase</u>	<u>Start</u> Feb 1998	<u>End</u> March 2001	<u>Subcontractor</u>
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Task 5B Planning will be completed before 1998 funding year.

Feb 1998-Jan 1999 - Collect gill tissue and other smolt and health information on a subsample of steelhead reared under various hatchery conditions; recollect and sample fish in tributaries and at Columbia and Snake River Dams; conduct laboratory assays; prepare reports.

Feb 1999-Jan 2000 - Collect gill tissue and other smolt and health information on a subsample of steelhead reared under various hatchery conditions; recollect and sample fish in tributaries and at Columbia and Snake River Dams; conduct laboratory assays; prepare reports.

Feb 2000-Sept 2000 - Collect gill tissue and other smolt and health information on a subsample of steelhead reared under various hatchery conditions; recollect and sample fish in tributaries and at Columbia and Snake River Dams.

Oct 2000 -Mar 2001- Prepare final reports

### PROJECT COMPLETION DATE:

March 2001

### CONSTRAINTS OR FACTORS THAT MAY CAUSE SCHEDULE OR BUDGET CHANGES:

ESA permits may be required if Columbia River steelhead are listed.

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## OUTCOMES, MONITORING AND EVALUATION

## SUMMARY OF EXPECTED OUTCOMES

### **Expected performance of target population or quality change in land area affected:**

The relative influence of various biological and physical variables on fish migration will be described; physiological measures from juvenile salmonids will be correlated to adult return rate. These data will be used to aid managers in choosing river management actions for the benefit of juvenile salmonids. The effect of various hatchery rearing strategies on steelhead smolt development will be determined and correlated with changes in residualism and precocity of steelhead.

### **Present utilization and conservation potential of target population or area:**

N/A

### **Assumed historic status of utilization and conservation potential:**

N/A

### **Long term expected utilization and conservation potential for target population or habitat:**

Information about the relation between smolt quality, environmental variables and survival can be used to optimize both hatchery and river management for ESA-listed stocks. Reducing residualism will reduce the threat of steelhead preying on ESA-listed salmon. If steelhead are listed as threatened or endangered, the rearing information we develop will be of use in a conservation hatchery/captive brood stock situation.

### **Contribution toward long-term goal:**

Improved information base for management of hydrosystem operations to improve protection and the passage survival of all Columbia River anadromous stocks of salmon and steelhead through the FCRPS. Increased protection of ESA-listed stocks without reducing the contribution of hatchery production to fisheries. Increased survival of chinook salmon ESUs in hatcheries by increased understanding of intrinsic factors responsible for survival.

### **Indirect biological or environmental changes:**

N/A

### **Physical products:**

N/A

### **Environmental attributes affected by the project:**

Objective 4 & 5A. Elucidation of the relations between intrinsic and extrinsic factors controlling in-river survival will increase the confidence with which fish and water managers regulate the river environment. Objective 5A & B. Information will be provided that will allow hatchery management practices to be altered.

### **Changes assumed or expected for affected environmental attributes:**

N/A

### **Measure of attribute changes:**

N/A

### **Assessment of effects on project outcomes of critical uncertainty:**

Objective 4. Analysis of data collected from various locations in the hydropower system and comparison of survival to adulthood of various groups will indicate whether our data are representative of fish in the river for a given year. Objective 5. Continued monitoring by cooperating agencies and will determine if the changes in hatchery practices result in expected improvements in survival, reduced residualism and precocity.

### **Information products:**

Objective 4. Annual reports describing and updating analyses of adult returns relative to smolt condition and health, and environmental factors. Objective 5. Initially the products will be data on smolt condition and health relative to hatchery practices and will be in annual reports and management reports to collaborating agencies. Final reports will evaluate the data relative to management options.

#### **Coordination outcomes:**

In the past this project provided an annual assessment of smolt condition to assist the management of the Water Budget and other flow augmentation to the best advantage of emigrating juvenile salmon and steelhead. Objective 4 of this project will provide a time series of smolt condition information that will contribute to a better understanding of the relationship between environmental conditions, smolt condition, smolt passage survival and adult production. Year-to-year coordination will be conducted with our cooperators.

### **MONITORING APPROACH**

Objective 4. In the context of peer-review, the region can determine if our analyses of data are appropriate and if the conclusions reached warrant consideration in management decisions. Objective 5. As many of the agencies in the region will be collaborators on these objectives, they will be able to measure the outcomes based on annual examination of data, involvement in annual reports and input in the adaptive management of the project.

#### **Provisions to monitor population status or habitat quality:**

This monitoring is inherent in the analyses of travel time and survival of PIT-tagged release groups and adult returns to specific hatcheries.

#### **Data analysis and evaluation:**

Data on smolt condition and health will be correlated with environmental factors, and adult returns. Similar data from steelhead work will be correlated with the rates of residualism and precocity.

#### **Information feed back to management decisions:**

Because we are collaborating with numerous agencies and the FPC, those agencies will be directly involved in analyses and consultations about experimental design and results.

#### **Critical uncertainties affecting project's outcomes:**

It is assumed that factors affecting early development and out migration are critical to survival to adult; however, it may be that in the short-term (e.g., the life of this project) factors in the estuary or ocean will override and dampen variability caused by early-life history. By continuing this project to establish the longer term database (e.g., 20+ yrs) that was part of the original (1987) intent, the relative importance of the various life-history stages would become evident.

### **EVALUATION**

Objective 4. Analysis of existing data and publication of results in BPA reports and peer-reviewed journals. Fish managers in the region will determine if the inclusion of data on smolt condition and health contributes to their understanding of variability in survival. Objective 5. Institution of changes in hatchery rearing practices that result in smolt condition and health indicative of increased survival, reduced residualism and precocity.

#### **Incorporating new information regarding uncertainties:**

Within an adaptive management context, we will consider new information within ongoing consultations with our numerous collaborators.

#### **Increasing public awareness of F&W activities:**

We will not be directly involved in outreach; however, our collaborators may have information officers who will advise the public of our work. We will cooperate with outreach programs as much as possible.

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## **RELATIONSHIPS**

## **RELATED BPA PROJECT**

8712700 Smolt Monitoring By Non-federal Entities

9302900 Survival Estimation for Dam/Reservoir Passage

9102900 Supplementation and Survival of Fall Chinook in Snake River

8332300 Smolt Condition & Arrival Timing At Lwr Granite

9005200 Performance/Stock Productivity Impacts of Hatchery Supplementation

(Contract #) 14-48-0001-93539

## **RELATED NON-BPA PROJECT**

Sockeye evaluation at Chiwawa Hatchery. Washington Dept. F&W, funded by Chelan County PUD

Immunomodulating diets: disease resistance and accelerated smoltification in salmon. Abernathy Salmon Culture Center, US Fish & Wildlife

Smoltification and residualization of steelhead reared in river water and constant temperature well water. WDFW funding from Chelan PUD and Grant PUD

Dworshak National Fish Hatchery Evaluations. US Fish & Wildlife Service, funding from US Army COE & Lower Snake Comp. Plan

Lower Snake River Hatchery Evaluation (Tim Whitesel, ODFW) funded by Lower Snake Comp. Plan

Movement, distribution and passage behavior of radio-tagged juvenile salmonids at three lower Columbia River dams. US Army COE

Evaluation of facilities for collection, bypass and transportation of outmigrating chinook salmon. Oregon State University funded by US Army Corps of Engineers

## **RELATIONSHIP**

We are collaborating to design experiments to determine the rate of residualism of Snake River hatchery steelhead.

We sub-sampled groups of PIT-tagged chinook and steelhead to determine condition and health of fish used for survival estimates

We assay gill ATPase, plasma cortisol and sodium for fall chinook salmon collected as part of this project.

We collect gill ATPase data from a portion of the fish PIT tagged at traps in the Snake River and its tributaries.

We help design and conduct experiments to assess the performance capacities of fish in various treatment groups

We assess gill ATPase and plasma cortisol of fish in treatment groups for this Lower Snake Comp. Plan project

## **RELATIONSHIP**

We have been monitoring smolt condition of sockeye in netpens in Lake Wenatchee

Collaborate in designing and conducting a study of immunomodulating feed on the smolt development and health of chinook salmon

We are collaborating to design experiments to reduce the residualism and precocity of hatchery steelhead.

We are collaborating to design experiments to reduce the residualism and precocity of hatchery steelhead, and hatchery evaluation of chinook.

We are developing a collaboration to assess the condition and health of fish used in PIT tag release groups.

We helped design and conduct lab & field experiments on the effects of radiotag implants on growth, smoltification and stress to juvenile chinook salmon.

We assayed gill ATPase activity of fish sampled during collection and transportation

## **OPPORTUNITIES FOR COOPERATION:**

This project currently cooperates with the Smolt Monitoring Program. We also collaborate with other BPA, COE and agency funded projects by providing assays of physiological variables and general consultation about fish condition and fish health, including projects conducted by WDFW, ODFW, IDFG, USFWS, & NMFS. In 1997 we will begin a collaboration with the US Fish & Wildlife Service and Washington Department of Fish & Wildlife to determine the best ways to insure that hatchery steelhead migrate immediately upon release and thus minimize their impact on other salmonids in the tributaries and mainstem. All of the projects listed in sections 60 and 70 above are cooperators with whom we collaborate on projects in which smolt condition and fish health are a part.

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## **COSTS AND FTE**

**1997 Planned:** \$231,803

**FUTURE FUNDING NEEDS:**

**PAST OBLIGATIONS (incl. 1997 if done):**



<u>FY</u>	<u>\$ NEED</u>	<u>% PLAN</u>	<u>% IMPLEMENT</u>	<u>% O AND M</u>	<u>FY</u>	<u>OBLIGATED</u>
1998	\$279,000	10%	90%		1987	\$109,199
1999	\$293,000	10%	90%		1988	\$260,130
2000	\$307,000	10%	90%		1989	\$281,998
2001	\$323,000	10%	90%		1990	\$295,092
2002	\$0				1991	\$303,761
					1992	\$363,186
					1993	\$420,043
					1994	\$685,997
					1995	\$465,468
					1996	\$469,445

TOTAL: \$3,654,319

Note: Data are past obligations, or amounts committed by year, not amounts billed. Does not include data for related projects.

**OTHER NON-FINANCIAL SUPPORTERS:**

N/A

**LONGER TERM COSTS:** N/A

If fisheries and water managers determine that information about smolt quality and health is useful in assessing the results of other studies, we will continue to provide that information beyond 2001.

**1997 OVERHEAD PERCENT:** 38%

**HOW DOES PERCENTAGE APPLY TO DIRECT COSTS:**

The 38% applies to total direct project costs.

**SUBCONTRACTOR FTE:** N/A